1-2018

# The Comprehensive PT Management Of A Patient With Chronic Low Back Pain And Lumbar Radiculopathy: A Case Report

Robin McGuire
*University of New England*

**University of New England**
**Department of Physical Therapy**
**PTH 608/708: Case Report Template**

Name: Robin McGuire

Please use this template for Week 2-12 assignments, as clearly outlined both in blackboard and the syllabus, by entering the necessary information into each section under the appropriate headers as assigned and submitting to blackboard. Once a section is complete and has been graded, you may delete the instructions provided in grey. Feel free to work ahead as your case allows, but only assigned sections will be graded by the due dates. Please start by adding your name above and in the header, and once you develop your title, a "running" or abbreviated title. This same template will be used for PTH708, and will be completed throughout the fall.

All responses should be in black text, 12-font, Times New Roman, and double-spaced with proper grammar and punctuation. Track changes must be switched OFF. Any assignments submitted in unacceptable condition as determined by the faculty will be returned to the student for resubmission in three days for a maximum score of 80%.

All case reports are written in *past tense*, so ensure that your submissions are past tense. No patient initials are necessary; please refer to your subject as "patient" throughout the manuscript.

**Academic Honesty:**

*You may use any resources at your disposal to complete the assignment. You may not communicate with other UNE students to obtain answers to assignments or share sources to submit. Proper citations must be used for referencing others' published work. If you have questions, please contact a PTH608 course instructor. Any violation of these conditions will be considered academic dishonesty.*

*By entering your name, you are affirming that you will complete ALL the assignments as original work. Completing an assignment for someone else is unethical and is a form of academic dishonesty.*

*Student Name: _____Robin McGuire_____ Date: ____6/10/17_____*

*By typing your name here, it is representative of your signature.*

# The Comprehensive PT Management of a Patient with Chronic Low Back Pain and Lumbar Radiculopathy: A Case Report

Robin McGuire

Robin McGuire is a DPT Student at the University of New England, 716 Stevens Ave. Portland, ME

Address all correspondence to Robin McGuire at rmcguire1@une.edu

The patient signed an informed consent allowing the use of his medical history and photo/video footage for this case report. He received information from the university's Health Insurance Portability and Accountability Act (HIPPA) policies.

The author acknowledges Mike Fillyaw, PT, MS for assistance with case report conceptualization and Nicole Ayotte, PT for supervising and assisting with patient management.

## ABSTRACT

Background and Purpose: Low back pain is the most common health problem among older adults resulting in pain and disability. Lumbar radiculopathy is a disabling condition causing low back pain that radiates into the lower extremity along the sensory distribution of the spinal nerve root. The purpose of this case report is to describe a comprehensive physical therapy plan for a patient with chronic low back pain and lumbar radiculopathy that included: therapeutic exercises using directional preference, interferential current, and manual traction.

Case Description: The patient was a 60-year-old male with lumbar radiculopathy due to nerve root compression. He presented with left sided low back that radiated into the anterior left hip while bending over and getting in and out of bed. His goal was to reduce pain with daily activities. The outcome measures included the Patient Specific Functional Scale, Oswestry Disability Scale, and the Numeric Pain Rating Scale. Interventions included manual traction, interferential current, and therapeutic exercise using the patient's directional preference for a period of 6 weeks.

Outcomes: After 14 days of a variety of interventions, the patient's ODI score improved from 60% to 54%. The patient increased his tolerance for walking from five minutes with 5-6/10 pain to 15 minutes with a 5-6/10 pain.

Discussion: This case report explored a variety of evidence based interventions for a patient with chronic low back pain and lumbar radiculopathy. Given the patient's history of multiple joint replacements and negative prognostic factors, the patient was unable to meet his PT goals. Future research should explore the impact of central sensitization and mental health on persistent/chronic pain, guiding physical therapists in the management of chronic musculoskeletal conditions.

Manuscript Word Count: 3,203

## BACKGROUND and PURPOSE

Low back pain is the most common health problem among older adults that results in pain, disability, and a medical burden leading to loss of work time.[1] Lumbar radiculopathy is pain in the lower extremities originating from compression at the nerve root in the lumbar spine. It is a widespread, often disabling condition causing low back pain that radiates into the lower extremity and/or foot along the sensory distribution of the involved spinal nerve root.[1] The American Physical Therapy Association (APTA) Clinical Practice Guideline (CPG) for Low Back Pain describes lumbar radiculopathy under the ICD diagnosis of lumbago with sciatica (ICD-10: M54.41).[2] Patient presentation is chronic, recurring low back pain with associated radiating pain and potential sensory, strength, or reflex deficits in the involved lower extremity. Symptoms are reproduced or aggravated with sustained end-range lower limb tension, straight leg raise, or slump tests.[3]

The management of low back pain includes a range of different interventions including drug therapy, surgery, and physical therapy. Physical therapy includes therapeutic exercise, electrical stimulation, individualized patient education, manual techniques, traction, superficial heat or cold, and others.[4] To determine the most effective treatment, a reliable decision-making algorithm can be used to place patients with low back pain into subgroups: Specific Exercise, Manipulation, and Stabilization. (Figure 1)[5] The objective and subjective findings described later in this case report confirm the patient's placement in the Specific Exercise subgroup. Additionally, the APTA CPG for low back pain strongly recommends the use of repeated exercises in a specific direction determined by treatment response to improve mobility and reduce symptoms in patients with chronic low back pain.[3] Directional preference is identified

when a repeated posture in a single direction (flexion, extension, or side-glide/rotation) decreases or abolishes lumbar pain and/or causes radicular symptoms to move away from the periphery and towards midline.[6] Further evidence-based interventions used in the management of patients with low back pain are Interferential Current (IFC) and manual traction. There is evidence that IFC improves functional ability and provides long term elimination of pain in patients with low back pain.[7] Manual traction is an intervention commonly used by physical therapists for patients with low back pain. While there is conflicting evidence to support the use of traction, there are some studies suggesting reduction in pain in patients with a positive manual unloading test.[8]

Given the variety of treatment approaches for patients with chronic back pain and lumbar radiculopathy, the purpose of this case report is to describe a comprehensive approach for a patient with chronic low back pain and lumbar radiculopathy using the following interventions: therapeutic exercises using directional preference, IFC, and manual traction.

## Case Description

### Patient History and Systems Review

The male patient was a 60-year-old retired mill worker who presented to physical therapy following referral from his primary care physician with a diagnosis of lumbar pain with radicular symptoms. Magnetic resonance imaging of the lumbar spine without contrast indicated mild multilevel changes of lumbar spondylosis with no high grade compressive discopathy at any level.

The patient had a primary complaint of left hip pain that had been getting worse for one year prior to this episode of care, when he underwent a left total hip arthroscopy (THA) followed by physical therapy. The patient reported difficulty getting in and out of bed and getting up from

a bent over position. The patient stated that while he could still perform most of his daily activities, there are some days that he must restrict all activity due to pain in left lower back region that radiates to the front of his left hip. He described his pain 7/10 at its worst and a 4/10 at its best on the Numeric Pain Rating Scale (NPRS). Patient stated he takes Gabapentin for symptoms of pins and needles into the front of his left hip and tramadol as needed for pain. Additional significant past surgical history included: left shoulder replacement in 2014 and right shoulder replacement in 2015.

The patient reported that he was independent with all activities of daily living (ADLs) and independent activities of daily living (IADLs). The patient was married and enjoyed watching television and taking trips to Bangor. He stated that he had no desire for hobbies and appeared to have a sedentary lifestyle. His primary goal was to reduce his pain. Table 1 describes the results obtained from the systems review. The patient signed an informed consent allowing the use of medical information for this case report.

**Clinical Impression 1**

This patient presented with nerve root impingement of L2-L4 on the left. His impairments included: decreased lumbar and left lower extremity range of motion and strength, tenderness to palpation in left lumbar/sacral regions, hypomobility of the lumbar spine, and postural/gait deviations. Differential diagnosis included: femoral nerve entrapment, lumbar stenosis, sacroiliac dysfunction, femoral acetabular impingement, and nerve root impingement with disc herniation. Tests and measures used to confirm the diagnosis included: femoral nerve tension test, straight leg raise, palpation of sacroiliac bony landmarks, and the spring test of lumbar spine.[9] Additional assessment included: range of motion and manual muscle testing of the

lower extremity and trunk, the Oswestry Low Back Disability Questionnaire, and the Patient Specific Functional Scale.[10]

This patient was an excellent candidate for a case report due to his past medical history of multiple joint replacements and the chronicity of his pain. Chronic low back pain is an extremely common diagnosis that will benefit from continued evidence that will guide physical therapists in best practice.

**Examination – Tests and Measures**

Results of the initial physical therapy examination are described in Table 2. The patient was interviewed using the Patient Specific Functional Scale (PSFS) to measure his ability to complete specific functional activities.[11] The patient was asked to rate the activities that he mentioned in the history portion of the examination on a scale from 0 (unable to perform) to 10 (able to perform).[11] While the reliability and validity are unknown for this test, this is a useful subjective measure of the patient's perception of their function and is an appropriate tool to assess their change in function over time. The Oswestry Low Back Disability Questionnaire (ODQ), also known as the Oswestry Disability Index, is a self-reported measure that assesses the symptoms and severity of low back pain and the extent to which the patient's leg or back pain impact their function.[12] The ODQ has been found to have internal consistency and excellent construct validity as well as superior discriminative ability when at higher levels of disability.[12] The patient received a disability score of 60%, indicating severe disability.[13]

The patient's trunk and lower extremity strength were assessed using manual muscle testing (MMT), a standardized assessment to measure muscle strength with a minimum of 0 and a maximum of 5. There is evidence for good reliability and validity of MMT for patients with

neuromuscular dysfunction.[14] He had pain with most MMT's of the trunk as described by Kendall FP et al.[15] and had weakness and pain with hip internal and external rotation bilaterally.[15] Passive range of motion (PROM) values as described by Norkin CC and White DJ[16] for the left hip are less than the right hip and lumbar flexion and extension are limited. Active range of motion (AROM) values as described by Norkin CC and White DJ[16] indicated decreased lumbar mobility. The straight leg raise (SLR) test was positive for radiculopathy at 40 degrees with the patient in supine.[9] This test has been shown to be a sensitive test for lumbar radiculopathy with a reproduction of the patient's lower back symptoms.[17] The Spring Test was used to for joint play assessment of the lumbar (L) spinous processes (SPs) and transverse processes (TPs). This test was performed using the ulnar border of the hand and was positive for pain in L2-L4 SPs and left TPs. Spring testing was performed as described by Kaltenborn et al.[18]Additionally, the patient had tenderness to palpation on the left lumbar musculature and sacral region. Palpation of pelvic bony landmarks with the patient in supine revealed pelvic malalignment. The left iliac crest, left medial malleoli, and left anterior superior iliac spine were about 1 inch higher than the right, indicating that the left ilium is higher than the right. Lumbar Quadrant Test confirmed foraminal narrowing in the lumbar spine with peripheralization of symptoms into the left and right L2-L4 dermatomal pattern, although symptoms were worse on the left.[9]

**Clinical Impression 2**

The patient's signs, symptoms, and examination confirmed the initial PT diagnosis of lumbar radiculopathy from nerve root impingement to L2-L4. His medical diagnosis/physical therapy diagnosis was: M51.16 (Intervertebral disc disorders with radiculopathy, lumbar region).[19]

The patient's functional limitations included: difficulty bending, twisting, and changing position with increased pain through the low back and into the left anterior hip. These impairments inhibited the patient's ability to perform pain-free ADLs. Due to the patient's chronic pain and multiple joint replacements, he was determined to be an excellent case to explore the most effective treatment of lumbar radiculopathy.

The patient's prognosis was determined to be fair based on the chronicity of the low back pain, multiple joint replacements, and high body mass index (BMI). Other negative prognostic factors included: low motivation, sedentary lifestyle, and low sense of self-efficacy and belief that he would make progress through PT. One study suggested that BMI is a relevant predictor of a patient's response to treatment and that participants that were obese were less likely to show gains from treatment.[20] Several studies have found an association between physical inactivity, obesity, and low back pain.[20,21,22] Despite these negative prognostic factors, the patient was willing to attend physical therapy twice a week and verbalized that he would be pleased with any improvement in his pain.

The planned procedural interventions included: therapeutic exercises using a lumbar flexed posture, electrical stimulation, lumbar mechanical traction, manual techniques (trigger point release, joint mobilizations, soft tissue massage). Based on the patient's positional preference for lumbar flexion, interventions focused on centralizing symptoms through a neutral or flexed lumbar spine. The patient's short and longer-term goals are listed in Table 3.

Coordination of care included communication with the referring physician with written progress notes every ten visits. Re-evaluation occurred at the 10$^{th}$ visit using the PSFS as the primary determinant of the patient's improvement as well as values for ROM, strength, pain

scale, and ODQ. Each visit, the patient was asked to verbalize his perceived improvement and consistency with his home exercise program.

## Interventions

### Coordination, Communication, Documentation

Patient communication included: discussing the results and significance of examination findings, determining the plan of care, and instructing the patient in home exercises. Prior to the start of treatment, the patient was educated on the role of PT and the importance of consistency with HEP given the chronicity of his low back pain. The patient agreed to participate in all treatment interventions.

### Patient Related Instruction

At each visit, the patient was asked to report his consistency with the home exercise program, his response to PT treatment after each session, and any questions or concerns he might have. When necessary, the patient received a handout of pictures and descriptions of his home exercise program, including the duration and frequency for each intervention. The initial evaluation, treatment encounter notes, and progress notes were saved using an electronic medical record system (EMR). All documentation was faxed to the referring physician.

### Procedural Interventions

The course of therapy consisted of 30-minute sessions, two sessions per week, for seven weeks. Table 4 describes a detailed timeline of each therapy session. The primary interventions have been placed into four categories: Manual Therapy, Therapeutic Exercise, IFC, and Aquatic Therapy.

<u>Manual Therapy</u>

Manual lumbar traction was chosen to reduce low back pain following a positive manual unloading test with the patient in supine in which he reported decreased peripheralization of symptoms and decreased low back pain. While the evidence suggests that the effect of lumbar traction on function is debatable, some studies have reported the benefits of traction.[25] One randomized controlled trial showed that those with peripheralization of symptoms with extension and a positive crossed straight leg raise had improved ODQ scores with mechanical traction.[10] Traction has the mechanical benefit of separating the vertebrae temporarily and if performed intermittently, it can help reduce circulatory congestion and relieve pressure on the dura, blood vessels, and nerve roots in the intervertebral foramina. Through improving circulation, it may also help decrease the concentration of noxious chemical irritants caused by swelling and inflammation. Additionally, there may be a neurophysiological response due to stimulation of mechanoreceptors.[4]

Therapeutic Exercise

The clinical practice guideline (CPG) of the Orthopedic Section of the APTA recommends the use of directional preference exercises to reduce symptoms in patients with chronic low back pain and mobility deficits.[3] This CPG suggests utilization of repeated movements will centralize symptoms. Given the patient's referred pain to the left anterior hip with extension and rotation and his relief of symptoms with lumbar flexion, the patient maintained a flexed or neutral lumbar spine during therapeutic exercises and stretches. Therapeutic exercise focused on core stabilization in supine and quadruped, as shown in Appendix 1. One systematic review on the use of therapeutic exercise for low back pain provides strong evidence for individually designed exercise programs as being at least as effective as other conservative treatments. This research also demonstrated significant improvement in pain levels

in groups that received strengthening and trunk stability exercises relative to other comparisons.[1] One multicentered randomized controlled trial of 312 patients with acute, sub-acute, and chronic pain identified a large subgroup with a directional preference.[6] Exercises matching a patient's directional preference reduced pain and medication use and improved outcomes compared to groups performing exercises that did not adhere to directional preference.[6] The patient was instructed to perform these exercises 1-2x/day to improve core strength and reduce pain.

Interferential Current

IFC was administered using Vectra Genisys Therapy System (DJO Global, Vista, CA) with the following parameters: 80-150 watts, 4000 Hz, sweep on, 16.0-17.0 CV for 20 minutes with 4 electrodes placed in an "x" pattern. A heating pad was placed on the low back for patient comfort with the patient in a 90-90 position as shown in Exercise #1 in Appendix 1 for patient comfort and pain reduction. IFC been shown to be more efficient in eliminating pain compared to Transcutaneous Electrical Nerve Stimulation (TENS) and high voltage electrical stimulation and can lead to significant improvement in disability, reduction of pain, and increased quality of life compared to massage.[7]

Aquatic Therapy

Upon re-examination at the patient's 10$^{th}$ visit, the patient's ODI score had decreased by 6% and he reported continual pain with his daily activities. Aquatic ~~T~~therapy was recommended to provide an environment for movement that would reduce the effects of gravity on the lumbar spine. For three sessions, the patient performed 30-45 minute aquatic therapy session **(**Appendix 2**)** with verbal cues to assume a flexed lumbar spine throughout. There is strong evidence recommending participation in endurance activities for patients with chronic low back pain.

Low-intensity, submaximal endurance activities for pain management and health promotion is recommended for patients with chronic, generalized low back pain.[1]

## OUTCOMES

Over the course of therapy, the patient reported minimal changes in pain and function. Final outcomes were not obtained due to the patient's decision to terminate PT and his physician's recommendation for imaging of his left hip. However, a re-examination occurred at the patient's 10th visit, as described in Table 2. His tests and measures included: positive SLR on the left, pain with active left lumbar rotation, difficulty standing up from a bent over position and getting in and out of bed. His VAS pain levels did not change and his ODI score decreased by 6%, indicating severe disability. At his 11th visit, the patient also noted that he had been walking 15 minutes without increasing his low back/hip pain.

Given the patient's sedentary lifestyle and his exacerbation of symptoms after 10 minutes of walking, aquatic therapy was recommended to reduce the effects of gravity on the lumbar spine.[1] Follow-up visits 10-11 included a 30-45-minute aquatic therapy session in which the patient reported very little pain during and after exercise. The patient stated his intended plan to continue his aquatic therapy program 1-2x/week **(**Appendix 2**)**.

## DISCUSSION

This case report described the comprehensive PT management of a patient with chronic low back pain and lumbar radiculopathy. Several factors informed the plan of care: the low back pain CPG, the Treatment Based Classification System (Figure 1), evidence based research, clinical judgement, and patient values.

Factors that may have negatively affected the patient's outcomes included: obesity, sedentary lifestyle, multiple joint replacements, motivation level, pain behavior, and pain chronicity. Chronic pain is believed to be a result of central sensitization and is present in many musculoskeletal disorders.[26] While there are no clinical tests to distinguish persistent pain from true nociceptive pain, there is research that can help guide clinicians in diagnosis. Signs that could indicate a developing or progressive central sensitization include: the appearance of new symptoms during-treatment, aggravation of existing symptoms, not responding to established treatments, post-exertional malaise, or a decreased pain threshold during hands-on treatment.[26]

Throughout PT treatment, the patient had diffuse fluctuating pain. While the patient originally presented with a directional preference of lumbar flexion, he occasionally presented with a directional preference of lumbar extension. Additionally, his pain location frequently changed from his low back to his hip. These signs are potential indicators of central sensitization that requires a unique PT approach. Nijs et al[26] outlines an algorithm and useful clinical tests to assist in the clinician in the diagnosis of central sensitization. Neblett[27] et al have created a Central Sensitization Inventory as a useful self-report screening instrument to diagnose Central Sensitivity Syndromes.

Once the presence of central sensitization in patients with chronic pain is diagnosed, clinicians should follow the guidelines from the low back pain CPG to inform pain education.[3] The CPG recommends PT education to promote an understanding of the neuroscience that explains pain behavior, and the importance of improvement in activity levels, not just pain relief.[3] Future research should aim to create concrete guidelines for PT assessment and treatment of patients with chronic pain involving central sensitization.

Furthermore, the patient demonstrated signs consistent with depression. There is research suggesting that mood disorders such as anxiety and depression are strong predictors of transitioning from acute to chronic pain.[28] Other factors such as high fear avoidance beliefs and pain catastrophizing are risk factors that impede healing in patients with chronic pain.[28] Physical therapists screen for mood disorders using outcome measures like the Hospital Depression and Anxiety Scale, and refer when indicated.

Lastly, as the low back pain CPG recommends, aerobic exercise is a vital aspect of the PT management of chronic low back pain.[3] Given the patient's low tolerance for physical activity, it would have been appropriate to recommend aquatic therapy earlier. The patient enjoyed exercising in the water with minimal complaints of exacerbating symptoms.

In conclusion, there are several factors to consider when managing patients with chronic pain including psychosocial factors and the presence of central sensitization. With continued research on the impact of mental health on chronic pain and the nervous systems role in persistent pain, physical therapists will provide better care to patients with chronic low back pain.

## REFERENCES


1. Hayden J. Exercise therapy for treatment of non-specific low back pain. *Cochrane Database of Systematic Reviews.* 2011(2). http://search.ebscohost.com/login.aspx?direct=true&AuthType=url,ip,uid&db=chh&AN=CD000335&site=ehost-live. Accessed Jul 7, 2017.
2. Neil A. Identifying the correct codes for ICD-10 (ICD-10-CM). http://www.apta.org/ICD10/IdentifyingCodes/. Accessed Jul 6, 2017.
3. Low back pain [A clinical practice guideline by the orthopaedic section of the american physical therapy association (APTA) (CPG+ analysis provided). American Physical Therapy Association Web site. http://www.ptnow.org/clinical-practice-guideline-detail/low-back-pain-clinical-practice-guideline-by-ortho. Updated 2012. Accessed Jul 7, 2017
4. Kisner C, Colby LA. *Therapeutic exercise.* 5. ed. Philadelphia: Davis; 2007.
5. Fritz JM, Brennan GP, Clifford SN, Hunter SJ, Thackeray A. An examination of the reliability of a classification algorithm for subgrouping patients with low back pain. Spine. 2006;31:77–82.
6. Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. *Spine*. 2004;29(23):2593-2602. Accessed Jul 13, 2017.
7. Rajfur J, Pasternok M, Rajfur K, et al. Efficacy of selected electrical therapies on chronic low back pain: A comparative clinical pilot study. *Med Sci Monit*. 2017;23:85-100. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5240899/. Accessed Jul 8, 2017. doi: 10.12659/MSM.899461.

8. Swanson BT, Riley SP, Cote MP, Leger RR, Moss IL, Carlos J. Manual unloading of the lumbar spine: Can it identify immediate responders to mechanical traction in a low back pain population? A study of reliability and criterion referenced predictive validity. *J Man Manip Ther*. 2016;24(2):53-61. Accessed Sep 26, 2017. doi: 10.1179/2042618614Y.0000000072.
9. Magee DJ. Orthopedic Physical Assessment. 6th ed. Edmonton, Alberta, Canada: Elesevier; 2014.
10. Fritz JM, Lindsay W, Matheson JW, et al. Is there a subgroup of patients with low back pain likely to benefit from mechanical traction? results of a randomized clinical trial and subgrouping analysis. *Spine*. 2007;32(26):793. Accessed Jul 8, 2017. doi: 10.1097/BRS.0b013e31815d001a.
11. Rehab measures-Patient Specific Functional Scale. The Rehabilitation Measures Database Web site. http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=890. Accessed Jun 10, 2017.
12. Rehab measures - Oswestry Disability Index. The Rehabilitation Measures Database Web site. http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=1114. Accessed Jun 10, 2017.
13. Saltychev MM, Mattie R, McCormick Z, et al. Psychometric properties of the oswestry disability index. *Int J Rehabil Re*. 2017; 3:1-7. Doi:10.1097.
14. Cuthbert SC, Goodheart J, George J. On the reliability and validity of manual muscle testing: A literature review. *Chiropractic & osteopathy*.

2007;15(1):4. http://www.ncbi.nlm.nih.gov/pubmed/17341308. doi: 10.1186/1746-1340-15-4.

15. Kendall FP. *Muscles.* 5. ed., international ed. ed. Baltimore [u.a.]: Lippincott Williams & Wilkins; 2005.
16. Norkin CC, White DJ. *Measurement of joint motion.* 4. ed. ed. Philadelphia, Pa: Davis; 2009.
17. Rabin A, Gerszten PC, Karausky P, et al. The sensitivity of the seated straight-leg raise test compared with the supine straight-leg raise test in patients presenting with magnetic resonance imaging evidence of lumbar nerve root compression. *Arch Phys Med Rehabil.* 2007;88(7):840-3. doi:10.1016/j.apmr.2007.04.016.
18. Kaltenborn, FM, Evjenth O, Kaltenborn, TB, Morgan D, Vollowitz, E. *Manual Mobilization of the Joints, Volume 2: The Spine.* 6th ed. Oslo, Norway: McGraw-Hill; 2012.
19. Neil A. Identifying the correct codes for ICD-10 (ICD-10 CM). http://www.apta.org/ICD10/IdentifyingCodes/. Accessed Jul 6, 2017.
20. Ewald SC, Hurwitz EL, Kizhakkeveettil A. The effect of obesity on treatment outcomes for low back pain. *Chiropr Man Therap*. 2016;24:48. Accessed Jun 22, 2017. doi: 10.1186/s12998-016-0129-4.
21. Björck-van Dijken C, Fjellman-Wiklund A, Hildingsson C. Low back pain, lifestyle factors and physical activity: A population based-study. *J Rehabil Med*. 2008;40(10):864-869. Accessed Jun 22, 2017. doi: 10.2340/16501977-0273.

22. Yang H, Haldeman S. Behavior-related factors associated with low back pain in the US adult population. *Spine*. 2016. Accessed Jun 22, 2017. doi: 10.1097/BRS.0000000000001665.

23. Rehab measures - numeric pain rating scale. The Rehabilitation Measures Database Web site. http://www.rehabmeasures.org/Lists/RehabMeasures/PrintView.aspx?ID=891. Accessed Jul 28, 2017.

24. Rehab measures – Roland-Morris Disability Questionnaire. The Rehabilitation Measures Database Web site. http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=1201. Accessed Jul 28, 2017.

25. Wegner I, Widyahening IS, van Tulder MW, et al. Traction for low-back pain with or without sciatica. *Cochrane Database Syst Rev*. 2013(8):CD003010. Accessed Jul 8, 2017. doi: 10.1002/14651858.CD003010.pub5.

26. Nijs J, Van Houdenhove B, Oostendorp RAB. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Man Ther*. 2010;15(2):135-141. Accessed Jul 31, 2017. doi: 10.1016/j.math.2009.12.001

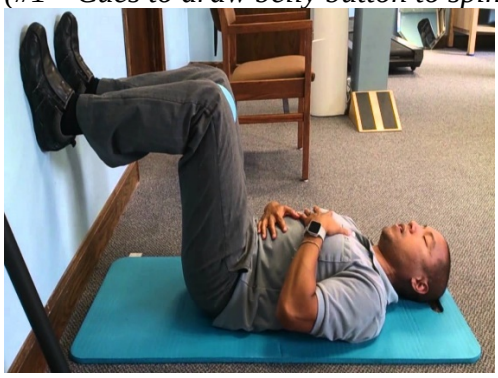
27. Neblett R, Cohen H, Choi Y, et al. The central sensitization inventory (CSI): Establishing clinically significant values for identifying central sensitivity syndromes in an outpatient chronic pain sample. *J Pain*. 2013;14(5):438-445. Accessed Jul 31, 2017. doi: 10.1016/j.jpain.2012.11.012.

28. Edwards RR, Dworkin RH, Turk DC, et al. Patient phenotyping in clinical trials of chronic pain treatments: IMMPACT recommendations. *Pain*. 2016;157(9):1851-1871. Accessed Aug 1, 2017. doi: 10.1097/j.pain.0000000000000602

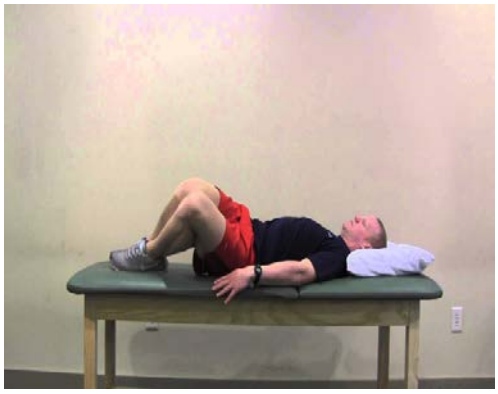
# APPENDICES

## Appendix 1. Therapeutic Exercises

**Exercise #1 & #2 90-90 Transverse Abdominal & Rectus Abdominal Exercise**
*(#1= Cues to draw belly button to spine. #2 Cues to flatten low back and draw ribs down towards feet)*



**Exercise #3 Hooklying Lower Lumbar Rotations**



**Exercise #4 Quadruped Cat Cow**
(*Verbal cues and tactile cues to promote full active range of motion while facilitating abdominal activation)*

## Appendix 2. Aquatic Therapy Flow Sheet

1. Warm up: forward/backward walking (5 min)
2. Warm up: side stepping (1 min)
3. Warm up: high knees (1 min)
4. Standing single leg hip abduction/flexion/extension (1 min)
5. Seated flutter kicks (1 min)
6. Seated leg bicycles (1 min)
7. Jogging in place (1 min)
8. Double leg hops (1 min)
9. Bicycles with noodle under armpits (1 min)
10. Alternating hip flexion/extension with extended knees with noodle (1 min)
11. Straight arm push downs using kick board (1 min)
12. Straight arm push/pull using kick board (1 min)
13. Cool Down: single leg hamstring stretch with heel on step (1 min/side)
14. Cool Down: seated figure four hip stretch (1 min/side)

## TABLES and FIGURES

**TABLES and FIGURES**

**Table 1. Systems Review**

| | |
|---|---|
| Cardiovascular/Pulmonary | Not impaired |
| Musculoskeletal | Impaired Gross Symmetry: seated and standing posture. Patient sits with weight shifted to right lower extremity and stands with a posterior pelvic tilt and weight shift to right lower extremity. Patient has internally rotated shoulders, externally rotated right lower extremity.<br><br>Impaired Range of Motion: left hip internal rotation, external rotation, flexion, extension. Trunk rotation, flexion, extension. Left shoulder flexion.<br><br>Impaired Gross Strength: bilateral hip flexion, adduction, internal rotation, external rotation. Trunk rotation, flexion, extension.<br>lower extremity and trunk strength, flexibility, and range of motion,<br><br>Impaired Height/Weight: Body Mass Index >25 |
| Neuromuscular | Impaired Gait, impaired patterns of movement with transfers and transitions. |
| Integumentary | Not impaired |
| Communication | Not impaired |
| Affect, Cognition, Language, Learning Style | Not impaired. Pt demonstrated no observable barriers to learning and was willing to participate in Physical Therapy. |

**Table 2. Tests & Measures**

| Tests & Measures | Initial Evaluation | | Visit 10 | |
|---|---|---|---|---|
| Gross Lower Extremity MMT[h] | Left | Right | Left | Right |
| Trunk Rotation | 5/5(pain) | 5/5(pain) | 5/5(pain) | NT |
| Trunk Flexion | | 4/5(pain) | NT | NT |
| Trunk Extension | | 4/5(pain) | NT | NT |
| Hip Flexion | 3+/5 | 3+/5 | 3+/5 | NT |
| Hip Abduction | 3-/5(pain) | 3+/5 | 4+/5 | NT |
| Hip Adduction | 3-/5(pain) | 3-/5 | 4+/5 | NT |
| Hip Internal Rotation | 3-/5 | 3-/5 | 3+/5 | 3-/5 |
| Hip External Rotation | 3-/5 | 3-/5 | 3+/5 | 3-/5 |
| Ankle Dorsiflexion | 5/5 | 5/5 | NT | 5/5 |
| Gross PROM[i] and AROM[j] | Left | Right | NT | |
| Hip Internal Rotation | 20 deg. | 35 deg. | | |
| Hip External Rotation | 12 deg. | 30 deg. | | |
| Hip Flexion | 85 deg. | 70 deg. | | |
| Hip Extension | 0 deg. | 0 deg. | | |
| Lumbar Rotation (AROM) | WNL[k] | Painful | | |
| Lumbar Extension/Flexion (AROM) | 25 deg. | | | |
| Numeric Pain Rating Scale | 4/10 best, 8/10 worst | | 4/10 best, 8/10 worst | |
| Oswestry Disability Index | 60% Disability | | 54% Disability | |
| Patient Specific Functional Scale | Getting in and out of bed (6/10) Standing up from flexed trunk (4/10) Total= 5/10 | | Total= 5/10 | |
| Straight Leg Raise | Positive: 40 deg[a] | | Positive: 40 deg | |
| Femoral Nerve Tension Test | Negative: Pain in left lumbar region | | Negative | |
| Spring Test | Pain reproduced: SPs[c] and TPs[d] L2-4[e] | | Not Tested | |
| Tenderness to Palpation | Left PSIS[f], Left sacral sulcus, Left lumbar paraspinals, Left QL[g] | | Not Tested | |

[a]deg, degrees, [b]ASIS, anterior superior iliac crest, [c]SP, spinous process; [d]TP, transverse process; [e]L2-4, lumbar levels 2-4, [f]PSIS, posterior superior inferior spine, [g]QL, quadratus lumborum, [h]MMT, manual muscle testing, [i]PROM, passive range of motion, [j]AROM, active range of motion, [k]WNL, within normal limits.

**Table 3. Goals**

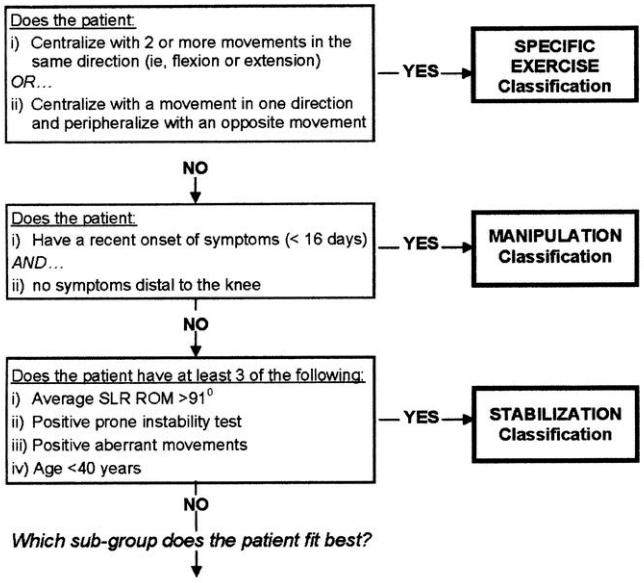
| Short Term Goals | Long Term Goals |
|---|---|
| 1. Patient will achieve decreased peripheralization of symptoms into left anterior hip for 50% of the day confirmed by subjective report so that he can perform ADLs with decreased pain. (4-5 weeks)<br>2. Patient will show independence with home walking program (10 min/day on flat surface) to increase physical activity (4-5 weeks)<br>3. Patient will demonstrate proper seated posture with equal weight distribution to decrease low back and hip pain to 1-2/10. (3-4 weeks) | 1. Pt will increase lower extremity active flexion and extension to 35 deg. to perform pain-free activities of daily living. (6-8 weeks)<br>2. Pt will achieve 5/5 strength through proximal hip musculature to reduce pain to 2/10 to return to ADLs with reduced pain/increased ease. (6-8 weeks)<br>3. Pt will achieve Oswestry Disability score of 40% to perform household tasks without pain. (6-8 weeks)<br>4. Pt will achieve average Patient Specific Functional Scale Score of 7/10 to decrease difficulty bending over and bed mobility. (6-8 weeks) |

**Table 4. Interventions**

| Interventions | | Treatment Day | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| **Manual Therapy** | Traction | | | | | | **x** | **x** | **x** | | | | |
| | Tender Point Release | **x** | | | | | | | **x** | | | | **x** |
| **Therapeutic Exercise** | TA Activation | **x** | | **x** | **x** | **x** | **x** | | **x** | | | | |
| | RA Activation | **x** | | **x** | **x** | **x** | **x** | | **x** | | | | |
| | Quadruped Cat Cow | | | | | | | | | | | | |
| | Hooklying L/S rotation | **x** | | **x** | | | **x** | **x** | | | | | |
| **Interferential Current with heat** | | | | | **x** | **x** | **x** | **x** | **x** | **x** | | | **x** |
| **Aquatic Therapy** | | | | | | | | | | | **x** | **x** | |

**“x”, interventions completed**

## Figure 1. Treatment Based Classification System for Patients with Low Back Pain[5]




| MANIPULATION | | STABILIZATION | | SPECIFIC EXERCISE | |
|---|---|---|---|---|---|
| **Factors favoring** | **Factors against** | **Factors favoring** | **Factors against** | **Factors favoring** | **Factors against** |
| ▪ More recent onset of symptoms<br>▪ Hypomobility with spring testing<br>▪ LBP only (no distal symptoms)<br>▪ Low FABQ scores (FABQW <19) | ▪ Symptoms below the knee<br>▪ Increasing episode frequency<br>▪ Peripheralization with motion testing<br>▪ No pain with spring testing | ▪ Younger age<br>▪ Positive prone instability test<br>▪ Aberrant motions present<br>▪ Greater SLR ROM<br>▪ Hypermobility with spring testing<br>▪ Increasing episode frequency<br>▪ 3 or more prior episodes | ▪ Discrepancy in SLR ROM (>10$^0$)<br>▪ Low FABQ scores (FABQPA < 9) | ▪ Strong preference for sitting or walking<br>▪ Centralization with motion testing<br>▪ Peripheralization in direction opposite centralization | ▪ Low back pain only (no distal sx)<br>▪ Status Quo with all movements |